

Using stable isotopes to assess and monitor anthropogenic nitrogen inputs to estuaries



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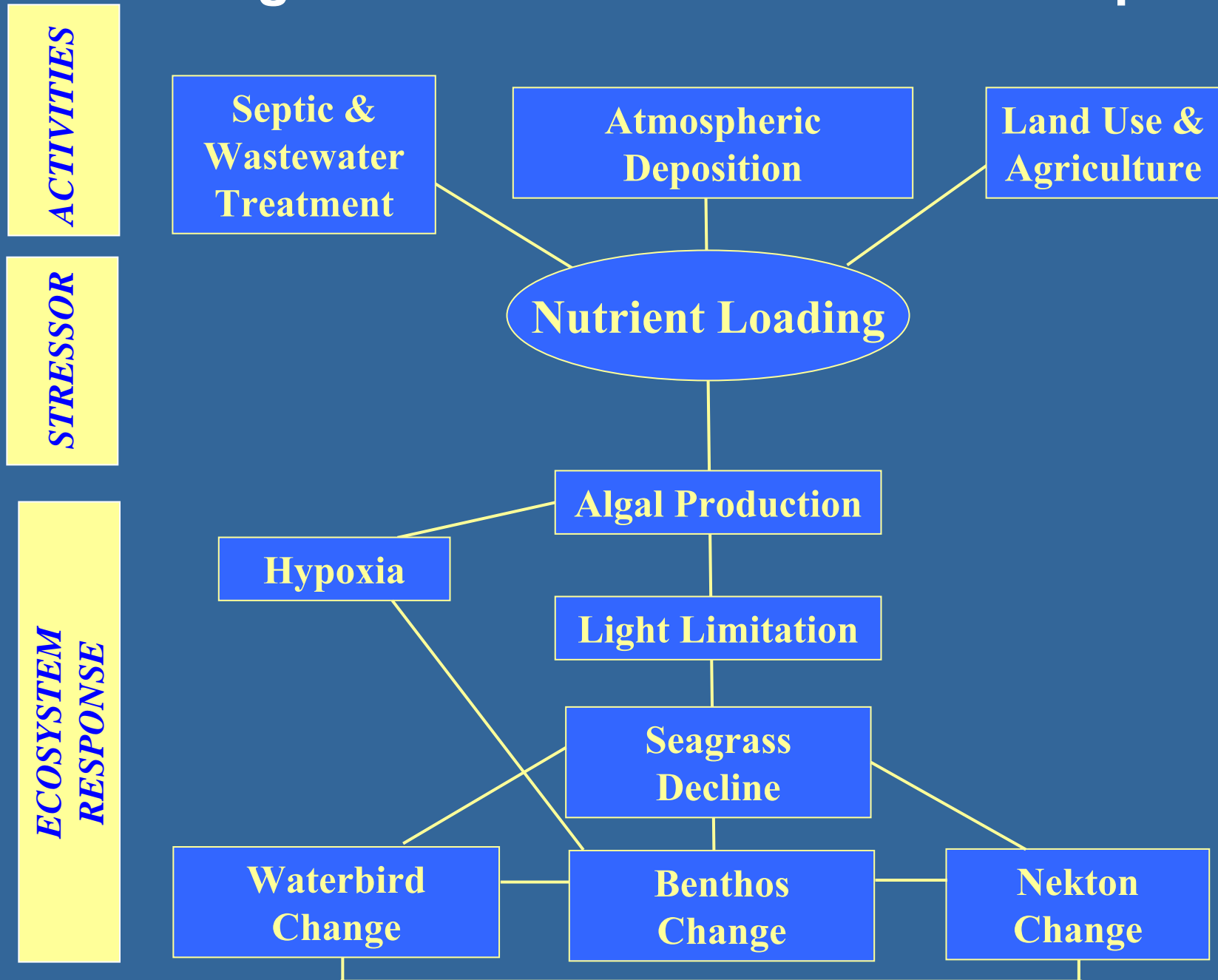
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National Park Service

Northeast Region



Nitrogen Enrichment & Estuarine Responses



Macroalgal Blooms



Nitrogen enrichment is one of the highest priority issues confronting Northeast Park estuaries (ACAD, CACO, FIIS, GATE, ASIS, COLO)

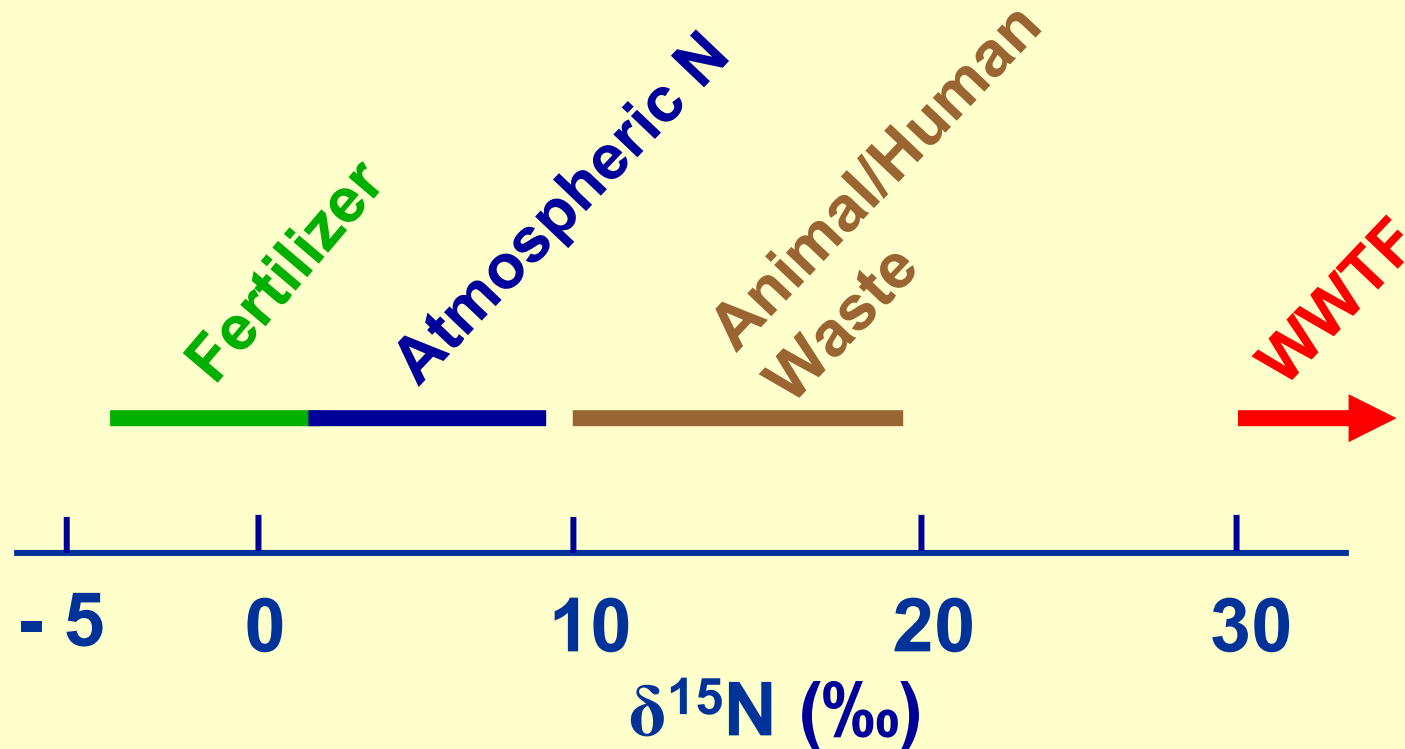
Research Goal

- As estuaries become increasingly degraded with excess nitrogen or as nitrogen inputs are reduced by improved wastewater treatment actions;
- *Is there an indicator available to detect changes in the source and magnitude of nitrogen inputs to estuaries over-time?*

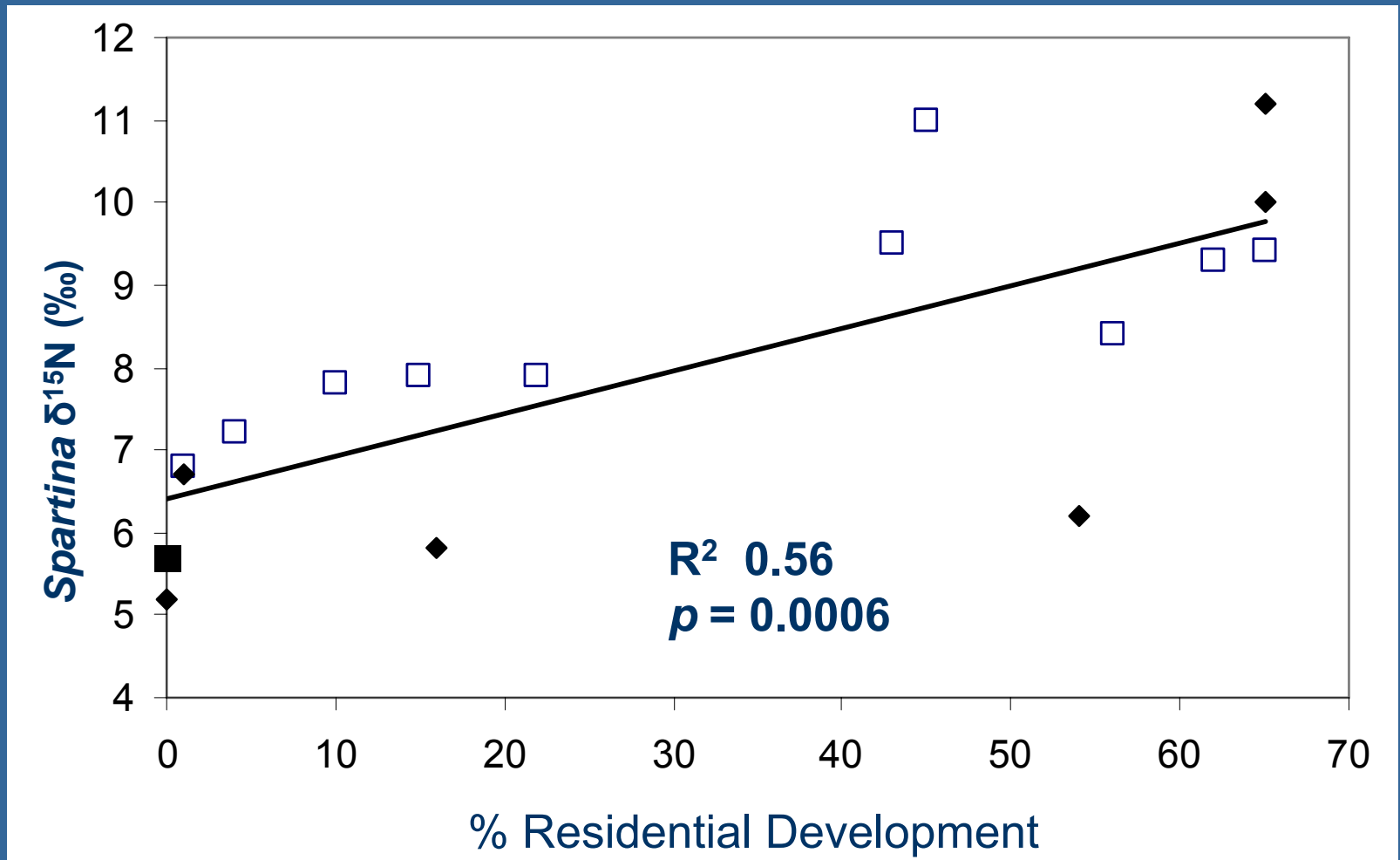


Stable Nitrogen Isotopes

Plants & animals assimilate nitrogen and their stable isotope ratios reflect the nitrogen source ratios (You are what you eat)



Relationship of $\delta^{15}\text{N}$ values with residential development



Data Sources: Wigand et al. 2001, Wozniak et al. 2006, This study.

Study Objectives and Study Design

Confirm the relationship between anthropogenic nitrogen inputs (watershed development) and stable N isotope values in consumers and producers (previous studies, e.g.;

McClelland and Valiela 1998, McKinney et al. 2001, Cole et al. 2006)

- *Sampled a gradient of sites from undeveloped to urban*

Using stable N isotopes, are particular organisms better or more sensitive indicators of change in nitrogen source and magnitude

- *Sampled a variety of estuarine organisms*



Spartina leaves



Ribbed Mussels



Mummichog



Ulva, Sea Lettuce



Hatches Harbor

- 0.01 people/km²

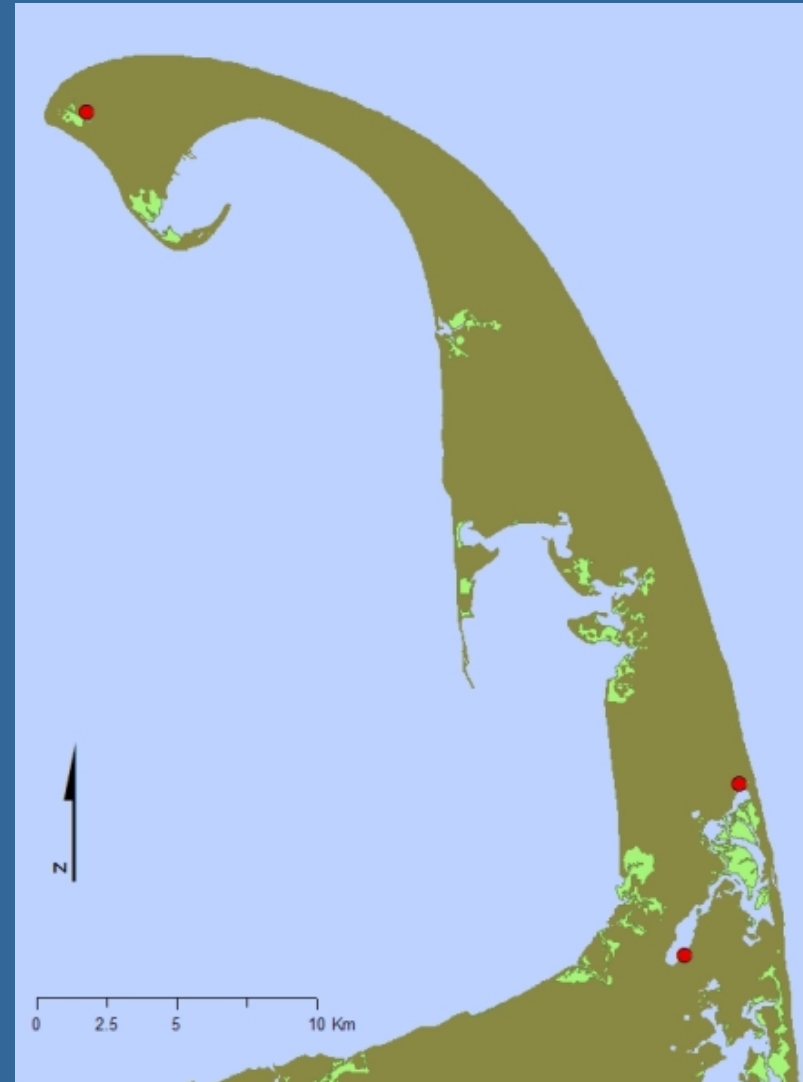
Nauset Bay

- 13 people/km²

Town Cove

- 253 people/km²

Cape Cod



West Sayville

- 1,480 people/km²



Fire Island wilderness

- 0 people/km²



Great South Bay, NY



Jamaica Bay

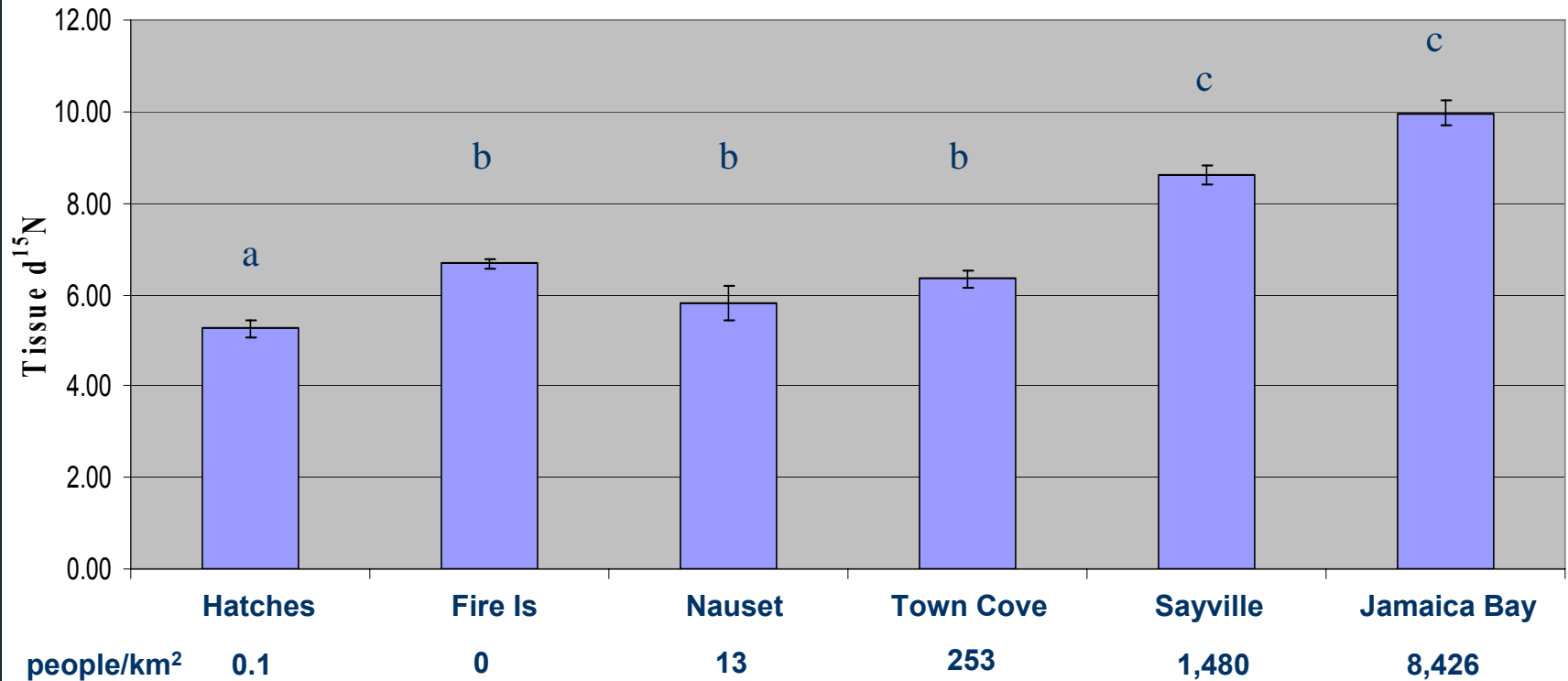
Gateway National Recreation Area



8,426 people/km²

**Total Population
1.8 million people**

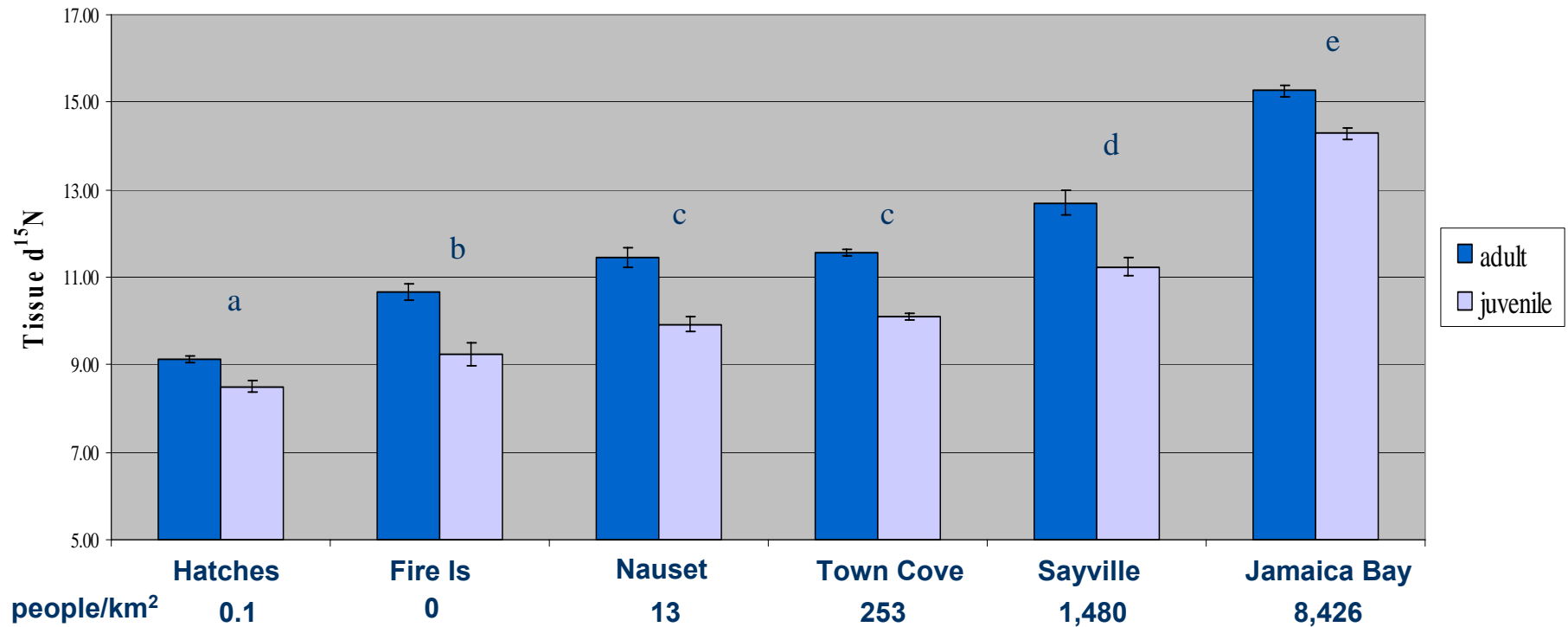
Spartina alterniflora



- Tissue $\delta^{15}\text{N}$ values of *S. alterniflora* increase along a watershed development gradient
- However, not sensitive to assumed differences in N loading between Sayville and Jamaica Bay; and Fire Island and Nauset



Common Mummichog (*Fundulus heteroclitus*)



$\delta^{15}\text{N}$ for Condition Assessment or Monitoring

What levels of $\delta^{15}\text{N}$ change would be meaningful to managers?

- Hatches Harbor vs Fire Island, 1.6 ‰ difference
- Town Cove vs. Sayville, 1.1 ‰ difference
- Probably interested in detecting < 1 ‰

Sample size necessary to detect differences with 80% power at $p \leq 0.05$

Difference in $\delta^{15}\text{N}$ value (‰)	Sample size				
	<i>Spartina</i>	<i>Geukensia</i>	Juvenile <i>Fundulus</i>	Adult <i>Fundulus</i>	<i>Ulva</i>
0.5	37	9	9	10	66
0.6	26	7	7	8	46
0.7	20	6	5	6	34
0.8	15	5	5	5	27
0.9	12	4	4	4	21
1.0	10	4	4	4	18

- For *Fundulus* or *Geukensia* a sample size of 10 would provide a reasonable probability of detecting a change when one truly exists
- *Spartina* is also a good indicator, but required larger sample size due to greater variability – More Cost

Implications for Assessment and Monitoring

- Stable N isotopes ($\delta^{15}\text{N}$), measured in consumer species (*Fundulus*, *Geukensia*) , over-time, are good indicators of the source and relative magnitude of nitrogen inputs to estuaries
- For undeveloped estuaries, monitoring stable N isotopes will be effective to determine if human-derived N is increasing
- For urban estuaries, the influence of wastewater plumes can be traced and response of the estuary to improvements in wastewater treatment can be monitored

Bannon, R.O., and C. T. Roman. 2008. Assessing the use of stable isotopes to monitor anthropogenic nitrogen inputs to estuarine systems. *Ecological Applications*, In Press.